NPSOR-91-001PR

NAVAL POSTGRADUATE SCHOOL

Monterey, California

AN OVERVIEW OF THE RESEARCH AND DEVELOPMENT SYSTEM IN THE U.S. NAVY

Kneale T. Marshall

July 1991

Prepared for:
Office of the Chief of Naval Operations (OP-914) and the Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL
Monterey, California

Rear Admiral R. W. West, Jr.
Superintendent

Harrison Shull
Provost

This Report was sponsored and funded by The Office of the Chief of Naval Operations (OP-914) and by the Naval Postgraduate School.

TABLE OF CONTENTS

1. Introduction.

This report is based on a briefing given by the author on 2 April, 1991 to the Naval Postgraduate School (NPS) faculty at the first Research Workshop organized by the Research Office. Its purpose is to give an overview of how research and development (R&D) activities are justified, programmed, organized and carried out. Emphasis throughout is on the Department of the Navy (DON). As the reader will see, the R&D enterprise is so vast that this report can only give a basic overview. References are given for readers wishing to pursue some area in more depth.

At the time of writing, plans are under way to reorganize the R&D laboratories. The descriptions, missions and programs presented here represent their current status before reorganization. It is too early to see clearly what the effects of the reorganization will be. These will be incorporated into future revisions of this report as appropriate. Plans for the reorganization can be found in reference (12).

2. Overview of the Navy and Marine Corps.

Before trying to describe the R&D activities of the DON, it is necessary to get a feeling for the overall size of the Department and what it does. The DON comprises both the US Navy and the US Marine Corps, and has the following mission:

> To be prepared to conduct prompt and sustained combat operations at sea in support of national interests; to defeat hostile military forces that threaten the continued free use of the seas by the United States and its allies, and to use maritime forces to project power ashore and influence the outcome of land battles through sea power.

To undertake this mission the navy and marine corps are large, complex, and highly technological organizations. Table 2-1 gives summary data that illustrate this. It is stressed that all data in this report are approximate. They are intended to show orders of magnitude and should not be used as a source of exact numbers of the various platforms, weapon systems, personnel, budgets etc. A more detailed and readily available source is the annual special edition on SeaPower (ref. (1)). An excellent description of the Soviet Navy is found in reference (2). A summary of all the world's navies (also armies and airforces) is found in reference (3).

Table 2-1 shows the result of the decision in the early 1980's to increase the size of the navy to 600 ships. That number was never reached, but the navy has achieved significant growth and new capabilities during this past decade. Central to the force projection and strike capability of the navy are its 14 carriers, each with approximately 90 aircraft and a total personnel complement of about 5000 that man the ship and the embarked air wing. The technology, planning, training, tactics and logistical support that allows these mobile airstations to operate at their

SHIPS

AIRCRAFT CARRIERS	14
BATTLE SHIPS	4
OTHER SURFACE COMBAT	208
SUBMARINES	136
AMPHIBIOUS WARFARE	66
LOGISTICS SUPPORT	131
PATROL & MINE WARFARE	9
	568

AIRCRAFT

TACTICAL COMBAT	2000
PATROL, SUPPORT, TRNG.	4000
	6000

MARINE DIVISIONS

ACTIVE	3
RESERVE	1

SHORE SUPPORT

NAVAL AIR STATIONS	47
NAVAL BASES	27
SHIPYARDS	8
RESEARCH LABS	17

SUPPLY SYSTEM

LINE ITEMS	3.1 MILLION
YEARLY FLEET DEMANDS	8 MILLION
YEARLY ACQUISITIONS	$11 BILLION
INVENTORY VALUE	$35 BILLION

MEDICAL SYSTEM

HOSPITALS	37
INPATIENTS	250,000/YEAR
OUTPATIENTS	12,000,000/YEAR

EDUCATION & TRAINING

OFFICERS

NAVAL ACADEMY	4,400
NROTC	66 UNIVERSITIES
NPS	1,200
WAR COLLEGE	200

ENLISTED

RECRUIT/SKILLS 68,000 MAN-YRS/YR

PERSONNEL

	USN	USMC	TOTAL
OFFICERS	73.000	20,000	93,000
ENLISTED	520,000	175,000	695,000
CIVILIAN			354,000
			1,142,000

ANNUAL BUDGET: $101.7 BILLION

RDT&E BUDGET: $2.2 BILLION

Table 2-1. Approximate Size and Complexity of the Department of the Navy.

current capacity, are all in large part a result of past investment in R&D. The same can be said for the other surface strike ships, the battleships and the Aegis cruisers, as well as their numerous complex specialty support vessels. The navy's strategic missile submarines play a key role in the nations triad of strategic forces, and its attack submarines continue to be among the most effective antiship and antisubmarine platforms.

This large air, surface and submarine force projects power in every ocean, supported by a large and complex shore establishment that is summarized in Table 2-1. This report will concentrate on that part with which NPS has significant interactions.

3. DON Policy and Program Planning.

Overall navy and marine corps policy is set by the Office of the Secretary of the Navy, called SECNAV. Development of plans to implement these policies, and programming of resources for carrying them out, are the responsibility of, for the Navy, the Office of the Chief of Naval Operations, called OPNAV, and for the Marine Corps, Headquarters Marine Corps. Both SECNAV and OPNAV are involved in the R&D program. Figure 3-1 shows in highly aggregated and simplified form the main lines of authority for the DON Research, Development, Test and Evaluation (RDT&E) program. The Marine Corps relies on the Navy laboratories and and administrative structure for its RDT&E. In this report the term navy RDT&E should be interpreted to include the Marine Corps when appropriate.

The individual responsible for RDT&E in DON is the Assistant Secretary of the Navy for Research, Development and Aquisition (ASN(RD&A)) in SECNAV. The Chief of Naval Research (CNR) and the basic research program have reported to SECNAV since their establishment following World War II. Recent changes have caused the applied research and development programs to come under much closer SECNAV supervision. These changes have been brought about in part by the widely publicized problems in the defense acquisition system, including cost overuns in both development and procurement.

Central to all navy and marine corps applied research and system acquisition are the navy Systems Commands, called SYSCOMs. These include a) Naval Air Systems Command (NAVAIR), b) Naval Sea Systems Command (NAVSEA), c) Space and Naval Warfare Command (SPAWARS), d) Naval Supply Systems Command (NAVSUP). These large entities are responsible for overseeing the development and acquisition of all navy and marine corps systems. The systems commands have until recently been part of the organization that reports to the CNO. Today the SYSCOMS report to SECNAV. Many NPS graduates are assigned to technical supervisory billets in these establishments when not assigned to their primary warfare operational duties at sea.

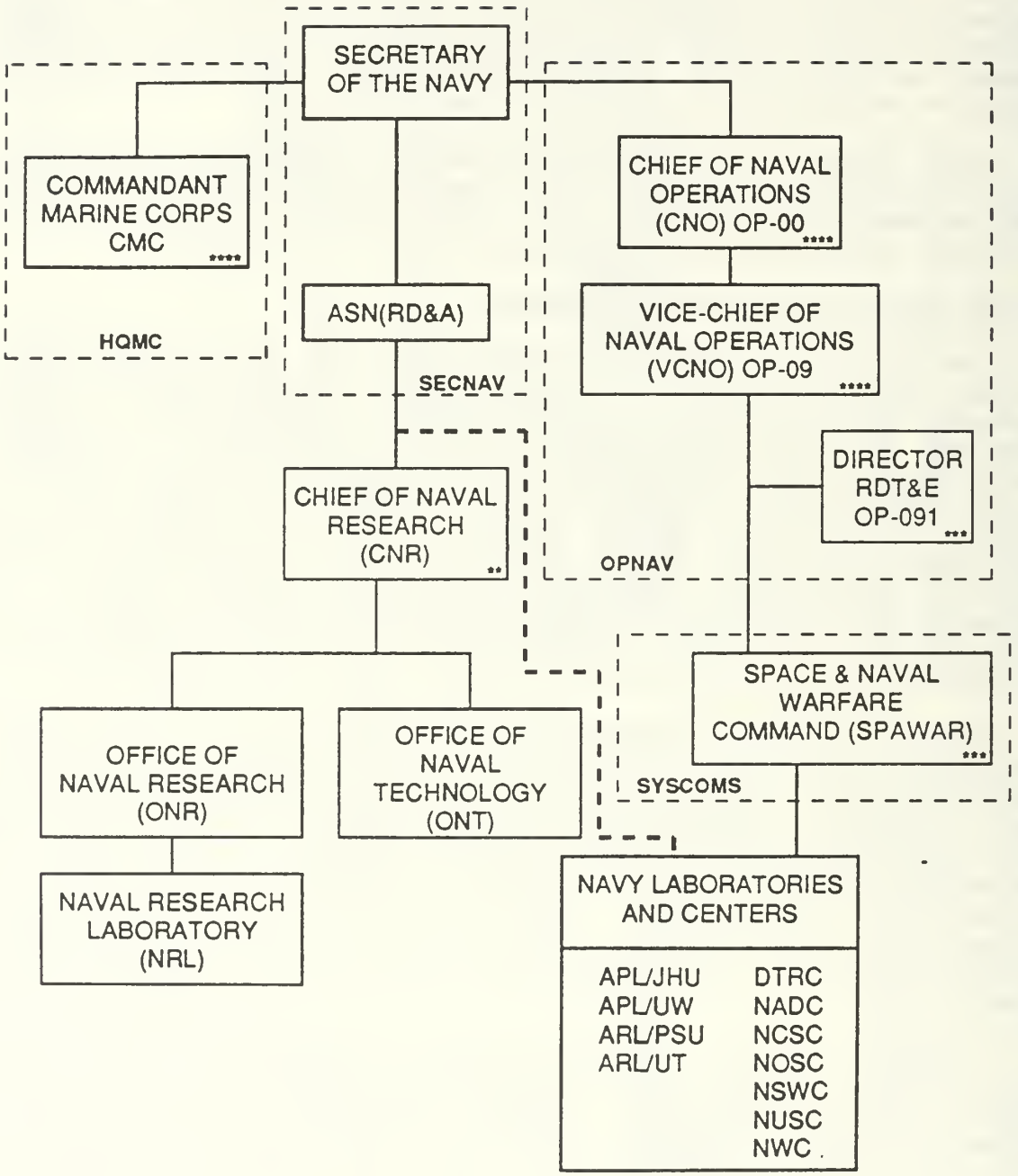

Figure 3-1: Simplified Organization Chart for DON RDT&E.

The following sections include descriptions of the overall RDT&E program, how it is organized by budget authority, responsibility for RDT&E requirements in program development, and overviews of the Naval Research Laboratory and the thirteen laboratories and centers that currently[1] report to SPAWARS.

4. The Requirements for RDT&E in DON.

The determination of requirements and program planning for all aspects of naval operations is the responsibility of the staff in OPNAV. One of the many offices under the Vice Chief of Naval Operations[2] (VCNO), OP-09, is the office of The Director of RDT&E Requirements, OP-091. A responsibility of this office to determine where best to place resources to maximize the effectiveness of RDT&E expenditures in the long-term support of naval operations. An important document that originates in this office is The Science and Technology Planning Guidance (ref (4)). This classified document gives the researcher important information as to where DON is heading with different programs. An unclassified breakdown of its contents is given in Table 4-1. The reader should note that requirements are determined and presented by warfare and support areas rather than by academic discipline. This breakdown will be seen often in this report.

Another source of R&D requirements, DOD-wide, is the Critical Technologies list (ref.(5)). This required list is prepared annually by the Office of the Secretary of Defense (OSD) for presentation to Congress, and is an indication of the increasing interest being exercised by Congressional committees over the defense RDT&E activities. A summary list of the current critical technologies is given in Table 4-2.

A third source of R&D requirements is the Exploratory Development Strategic Plan (ref. (6)) put out by the Office of Naval Technology. A summary list of their areas of interest is given in Table 4-3. Reference (6) explains the navy interpretaion of the categories in (5) and notes those areas of particular importance to naval and amphibious operations.

---

[1] The reporting chain of all DON labs and their structure are currently undergoing changes as laid out in reference (12). Some lab realignment will take place, but it is believed that their fundamental areas of responsibility as described in this report will not be greatly affected in the near future.

[2] The Naval Postgraduate School is an echelon-2 command that reports to the VCNO via the Assistant VCNO OP-09B.

SCIENCE & TECHNOLOGY PLANNING
GUIDANCE

MAY 1990

STRUCTURE

- AAW
- AMPHIB
- ASW
- LOGISTICS
- MANPOWER/PERSONNEL/TRAINING
- MINE
- SPACE & ELECTRONIC COMBAT
- SPECIAL OPERATIONS
- STRIKE/ASUW
- SUSTAINABILITY

PREPARED BY THE DIRECTOR, OFFICE OF RESEARCH AND DEVELOPMENT REQUIREMENTS, TEST AND EVALUATION, OP-091

Table 4-1. Categories of RDT&E Requirements within DON

GROUP A:

- COMPOSITE MATERIALS
- COMPUTATIONAL FLUID DYNAMICS
- DATA FUSION
- PASSIVE SENSORS
- PHOTONICS
- SEMICONDUCTOR MATERIALS & MICROELECTRONIC CIRCUITS
- SIGNAL PROCESSING
- SOFTWARE PRODUCIBILITY

GROUP B:

- AIR-BREATHING PROPULSION
- MACHINE INTELLIGENCE & ROBOTICS
- PARALLEL COMPUTER ARCHITECTURES
- SENSITIVE RADARS
- SIGNATURE CONTROL
- SIMULATION & MODELING
- WEAPON SYSTEM ENVIRONMENT

GROUP C:

- BIOTECHNOLOGY MATERIALS & PROCESSES
- HIGH-ENERGY DENSITY MATERIALS
- HYPERVELOCITY PROJECTILES
- PULSED POWER
- SUPERCONDUCTIVITY

Table 4-2. The DOD Critical Technologies List by Priority Group.

- ADVANCED MICROELECTRONICS
- HUMAN FACTORS & TRAINING
- LASERS
- ELECTRO-OPTICS
- ADVANCED OPTICAL TECHNOLOGY
- ACOUSTICS
- RADAR TECHNOLOGY
- OCEAN SCIENCES
- INFORMATION TECHNOLOGY
- HYDRODYNAMICS & CONTROL
- PROPULSION
- DIRECTED ENERGY
- POWER SOURCES
- ADVANCED MATERIALS & STRUCTURES
- SUPERCONDUCTIVITY
- BIOTECHNOLOGY

Table 4-3. The DON Critical Technology List.

5. Overall DON RDT&E Program Structure.

Before describing the various laboratories and centers that undertake or contract RDT&E, we present an overall view of the system based on Figure 3-1. For a more complete review of the DON RDT&E system, see reference (7).

Program 6 of the federal budget is RDT&E, the resources appropriated to carry on all aspects of the process from basic research through operational systems development. Table 5-1 gives the breakdown of budget categories within program 6 that the reader will need to know to understand R&D funding sources.

6.1	BASIC RESEARCH
6.2	EXPLORATORY DEVELOPMENT
6.3	ADVANCED DEVELOPMENT
6.4	ENGINEERING DEVELOPMENT
6.5	MANAGEMENT & SUPPORT
6.6	OPERATIONAL SYSTEMS DEVELOPMENT

Table 5-1. DOD RDT&E Program by Budget Appropriation.

Historically, the most common subcategories with which NPS has been involved are 6.1 and 6.2. Through fiscal year 1986 (FY86) NPS research was funded totally by reimbursible funds, mostly but not entirely in these categories. This included the so-called NPS Foundation Research Program[3], a block of 6.1 and 6.2 money sent to NPS directly from the Chief of Naval Research (CNR), allocated and administered by NPS, and the results reviewed biennially by ONR. The Direct Funded Research (DFR) program was instituted in 1987 by the Secretary of the Navy. Reference (8) is the current SECNAV Instruction that governs funding of NPS research. The original version prevented NPS from accepting any navy reimbursible RDT&E funds. Since its inception, except for capital equipment, it has been funded from the same budget category as the NPS regular budget, namely the "Operations and Maintenance, Navy" account (O&MN). All capital equipment (currently any equipment costing over $15,000) must be paid for out of the "Other Purchases, Navy" account (OPN). Communications with the Office of the Comptroller of the Navy have resulted in an easing of restrictions imposed by reference (8). These have been communicated to the faculty who are again encouraged to find reimbusible navy funding.

[3] The reader should not confuse this (now defunct) Foundation Research Program with the ongoing Naval Postgraduate Foundation. The latter is an active private not-for-profit organization whose charter is to assist NPS. One of its activities, made possible through an endowment by the widow of the late NPS Dean of Research, Carl Mennekin, is an annual award for the most significant research contribution by a NPS faculty member during the previous 12 months.

The total basic research program (6.1) is broken into subcategories for budget, programming and execution purposes. These subcategories are shown in Table 5-2. As the reader can see, they follow quite closely the standard academic disciplines. One can also see clearly that no provision has been made for research areas outside the main theme of science and engineering. Congress appropriates no program 6 funds in areas vital to DOD/DON such as International Law and Policy, Political Science, or Management (in its many forms and subcategories). Since over one third of NPS faculty are involved in such areas, some remarks are included later in this report as to possible sources of interest and support.

- GENERAL PHYSICS
- RADIATION SCIENCES
- CHEMISTRY
- MATHEMATICS
- COMPUTER SCIENCES
- ELECTRONICS
- MATERIALS
- MECHANICS
- ENERGY CONVERSION
- OCEAN SCIENCES
- OCEAN GEOPHYSICS
- ATMOSPHERIC SCIENCES
- BIOLOGICAL & MEDICAL SCIENCES
- BEHAVIORAL SCIENCES
- UNIVERSITY RESEARCH INSTRUMENTATION
- MULTIDISCIPLINARY SUPPORT

Table 5-2. Basic Research Program Structure (6.1).

Table 5-3 gives the subcategories of the exploratory development program (6.2). The categories follow the main warfare areas with which most of our students (all the unrestricted line (URL) and some of the restricted line (RL) and staff officers) are associated. There are opportunities within these categories for research funding in various management areas, but it is still hard to see where international law and policy or political science fit in.

- AAW	ANTIAIR WARFARE
- ASUW	ANTISURFACE SHIP WARFARE
- STW	STRIKE WARFARE
- EW	ELECTRONIC WARFARE
- ASW	ANTISUBMARINE WARFARE
- MW	MINE WAREFARE
- SPW	SPECIAL WARFARE
- AMW	AMPHIBIOUS WARFARE
- MOB	MOBILITY
- C3I	COMMAND, CONTROL & COMMUNICATIONS
- INT	INTELLIGENCE
- CON	CONSTRUCTION
- FSO	FLEET SUPPORT OPERATIONS
- LOG	LOGISTICS
- NCO	NONCOMBAT OPERATIONS
- STS	STRATEGIC SEALIFT

Table 5-3. Exploratory Development Program Structure (6.2).

The organizations primarily involved in supervising or contracting out RDT&E are shown in Table 5-4.

The Chief of Naval Research (a Rear Admiral of the Line) reports directly to the Assistant Secretary of the Navy for Research, Development and Acquisition in SECNAV. Directly under him are two organizations with which NPS faculty often deal directly, the Office of Naval Research (ONR) and the Office of Naval Technology (ONT).

ONR has responsibility for essentially all the basic research program, the 6.1 funds. As can be seen in Table 5-4, it is a world-wide organization with offices in Tokyo and London, whose charter includes monitoring basic science and engineering R&D that might have implications for future DON systems. As mentioned above, ONR was a major supporter of NPS research before DFR was instituted. The internal structure of ONR is shown in Table 5-5. The reader can see that it is organized primarily along academic disciplines. It is a major source of funding for basic research in universities. It also runs the Naval Research Laboratory (NRL) that is described later in this report, and the Naval Oceanographic and Atmospheric Research Laboratory (NOARL). This latter is a tennant activity at NPS in Monterey.

ONT is colocated with ONR in Ballston Towers in Arlington, Va., and controls essentially all the 6.2 and 6.3A funds. Table 5-6 shows the internal structure of ONT. The reader can again see clearly the categorization changes from academic discipline to

OFFICE OF NAVAL RESEARCH (ONR)
- OPERATES NAVAL RESEARCH LAB (NRL) & NAVAL OCEANOGRAPHIC & ATMOSPHERIC RES. LAB
- FUNDS BASIC RESEARCH AT UNIVERSITIES
- WORLD-WIDE LIAISON ON BASIC RESEARCH

NAVAL SYSTEMS COMMANDS		LABS
- SPACE WARFARE	(SPAWARS)	9
- AIR SYSTEMS	(NAVAIR)	6
- SEA SYSTEMS	(NAVSEA)	2
- SUPPLY SYSTEMS	(NAVSUP)	1

OTHER NAVAL LABS	
- NAVAL FACILITIES	1
- NAVAL MEDICAL	8
- MILITARY PERSONNEL	1

NOT-FOR-PROFIT RESEARCH CENTERS	
- APPLIED PHYSICS LAB	- JHU
- APPLIED PHYSICS LAB	- UW
- APPLIED RESEARCH LAB	- PSU
- APPLIED RESEARCH LAB	- UT
- MARINE PHYSICS LAB	- SCRIPPS INSTITUTE
- SYSTEMS RESEARCH CTR	- VPI
- CTR FOR NAVAL ANALYSES	- CNA

Table 5-4. DON R&D Organizations.

warfare areas as the funding changes from categories 6.1 to 6.2 or higher.

MATHEMATICAL & PHYSICAL SCIENCES

- MATHEMATICAL SCIENCES
- PHYSICS
- ELECTROCHEMICAL
- ELECTRONICS

OCEAN SCIENCES

- OCEAN ENGINEERING
- OCEAN & ATMOSPHERIC PHYSICS
- OCEAN BIOLOLOGY/OPTICS/CHEMISTRY
- GEO-ACOUSTICS/ARCTIC SCIENCES

ENGINEERING SCIENCES

- MATERIALS
- MECHANICS
- COMPUTER SCIENCE

LIFE SCIENCES

- BIOLOGICAL SCIENCES
- COGNITIVE & NEURAL SCIENCES

Table 5-5. Structure of the Office of Naval Research.

DIRECTORATES

- ANTIAIR WARFARE, ANTISURFACE WARFARE, SURFACE & AEROSPACE TECHNOLOGY (AAW/ASUW/SAT)
- ANTISUBMARINE WARFARE, UNDERWATER SYTEMS TECHNOLOGY (ASW/UT)
- LOW OBSERVABLES
- SUPPORT TECHNOLOGY
- INDUSTRY IR&D

Table 5-6. Structure of the Office of Naval technology.

6. The Navy Research Laboratories.

This section contains short descriptions of those navy inhouse RDT&E laboratories with which NPS programs and faculty interests are most closely aligned. These include the lead lab, The Naval Research Lab, nine labs that currently report to SPAWAR (see Figure 3-1).

a) The Naval Rearch Laboratory (NRL) is located across the river from National Airport in the Washington DC area, and as previously stated, is the lead navy lab that reports to ONR. Table 6-1 shows its mission, its overall organization, and its size in terms of personnel and annual budget.

MISSION

TO CONDUCT A BROADLY BASED MULTIDISCIPLINARY PROGRAM OF SCIENTIFIC RESEARCH AND ADVANCED TECHNOLOGICAL DEVELOPMENT DIRECTED TOWARD NEW AND IMPROVED MATERIALS, EQUIPMENT, TECHNIQUES, SYSTEMS, AND RELATED OPERATIONAL PROCEDURES FOR THE NAVY.

TECHNICAL DIRECTORATES

- GENERAL SCIENCE & TECHNOLOGY
- WARFARE SYSTEMS & SENSORS RESEARCH
- MATERIALS SCIENCE & COMPONENT TECHNOLOGY
- NAVAL CENTER FOR SPACE TECHNOLOGY

PERSONNEL

- TECHNICAL	1588
- OTHER	1866
	3454

BUDGET

$627M

Table 6-1. The Naval Rearch Laboratory (NRL).

NRL puts out annual reports that give an excellent summary of its program and its facilities (see references (9) and (10)). NPS is well connected with NRL. The navy satellite in Halligan Hall was donated to NPS by NRL. Table 6-2 lists some selected research areas that illustrate its activities.

- FERROUS ALLOY PHASE TRANSFORMATIONS
- GLASS FIBERS AND METALLIC CORES
- AIRBORNE INFRARED SIGNATURE MEASUREMENT
- EWCM PROTOTYPE
- VACUUM MICROELECTRONICS
- CHARGED PARTICLE BEAMS AND DIRECTED ENERGY
- COMMUNICATIONS NETWORKS
- IMAGE RECOGNITION
- OCEAN ACOUSTICS AND SURFACES
- OPTICAL SYSTEMS
- HIGH-SPEED SOLAR WIND STREAMS
- CHAOS IN MAGNETOSPHERIC PARTICLE DYNAMICS
- HIGH DENSITY EXPLOSIVES AND PROPELLANTS
- NUMERICAL SIMULATING, COMPUTING AND MODELING

Table 6-2. Selected Research Areas at the Naval Research Lab.

The remainder of this this section describes briefly the seven RDT&E laboratories that until recently reported to SPAWARS (see reference (12)). More detailed descriptions of each can be found in reference (11).

b) The David Taylor Research Center (DTRC) is located in the Washington DC area just outside the beltway at Carderock, Md. Tables 6-3 and 6-4 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR NAVAL VEHICLES AND LOGISTICS AND FOR PROVIDING RDT&E SUPPORT TO THE US MARITIME ADMINISTRATION AND THE MARITIME INDUSTRY.

TECHNICAL DEPARTMENTS

- SHIP EM SIGNATURES
- SHIP HYDROMECHANICS
- SHIP ACOUSTICS
- SHIP MATERIALS ENGINEERING
- SHIP STRUCTURES AND PROTECTION
- PROPULSION AND AUXILLIARY EQUIPMENT
- COMPUTATION, MATHEMATICS & LOGISTICS
- SYSTEMS

PERSONNEL

- TECHNICAL	1435
- OTHER	1485
	2920

BUDGET

- BASIC RESEARCH	$ 10M
- OTHER RESEARCH	$251M
- OTHER APPROP.	$135M
	$396M

Table 6-3. The David Taylor Research Center (DTRC).

SUBMARINES

- ADVANCED SUBMARINE TECHNOLOGY
- SUBMARINE PROTECTION AND SURVIVABILITY
- COMPOSITE MATERIALS
- ELECTROMAGNETIC LAUNCHERS
- INTEGRATED ELECTRIC DRIVE

SURFACE SHIPS

- EM SIGNATURE REDUCTION
- NON-ACOUSTIC SIGNATURE MEASUREMENT AND MODELING
- INTEGRATED ELECTRIC DRIVE
- SHIP PROTECTION AND SURVIVABILITY
- ADVANCED SHIPBOARD MACHINERY

UNMANNED UNDERWATER VEHICLES

ADVANCED VEHICLES

- LANDING CRAFT, AIR CUSHION (LCAC)
- SMALL WATERPLANE AREA TWIN HULL (SWATH)
- SURFACE EFFECTS SHIPS (SES)

MARINE CORPS

- AMPHIBIAN VEHICLES
- LIGHTWEIGHT ARMOR
- ADVANCED ENGINE TECHNOLOGY

LOGISTICS

- NAVY MANUFACTURING TECHNOLOGY
- NAVY CAD II ACQUISITION
- OPERATIONAL LOGISTICS WARGAMING

Table 6-4. Selected Research at David Taylor Research Center (DTRC).

c) The Naval Air Development Center (NADC) is located in Warminster, Pa. and is the primary navy lab for aircraft and avionics R&D. Tables 6-5 and 6-6 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR NAVAL AIRCRAFT SYSTEMS, LESS AIRCRAFT-LAUNCHED WEAPONS SYSTEMS.

TECHNICAL DEPARTMENTS

- ANTISUBMARINE WARFARE SYSTEMS
- TACTICAL AIR SYSTEMS
- WARFARE SYSTEMS ANALYSIS
- COMMUNICATION NAVIGATION TECHNOLOGY
- MISSION AVIONICS TECHNOLOGY
- AIR VEHICLE AND CREW SYSTEMS TECHNOLOGY
- SYSTEMS AND SOFTWARE TECHNOLOGY

PERSONNEL

- TECHNICAL	1533
- OTHER	1008
	2541

BUDGET

- BASIC RESEARCH	$ 7M
- OTHER RESEARCH	$297M
- OTHER APPROP.	$129M
	$433M

Table 6-5. The Naval Air Development Center (NADC).

SYSTEMS PROGRAMS

- NAVSTAR GLOBAL POSITIONING SYSTEM
- V/STOL AIRCRAFT
- F/A-18 BLOCK UPGRADES
- CARRIER ASW MODULE
- ASW AIRCRAFT WEAPONS SYSTEMS
- ADVANCED AVIONICS TECHNOLOGY
- ADVANCED TACTICAL SURVEILLANCE
- OCEANOGRAPHIC SYSTEMS PROGRAM
- JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM
- WARFARE SYSTEMS ARCHITECTURE
- ASW AVIONICS IMPROVEMENT
- NAVY ADVANCED TACTICAL FIGHTER

TECHNOLOGY PROGRAMS

- ADVANCED ANTI-ELECTRONIC WARFARE RADAR
- AIRCRAFT MATERIALS AND CORROSION PROTECTION
- COMPOSITE STRUCTURES FOR AIRCRAFT
- OCEANOGRAPHIC TECHNOLOGY
- LASER EYE PROTECTION
- ARTIFICIAL INTELLIGENCE APPLICATIONS
- INFRA-RED SEARCH AND TRACK
- ADVANCED AIRSHIP PROGRAM
- LOW OBSERVABLE VEHICLE TECHNOLOGY
- UNMANNED AIR VEHICLE SYSTEMS
- TACTICAL SURVEILLANCE SONOBUOY
- OPTICAL COMPUTING AND NETWORKING
- HELMET MOUNTED DISPLAYS
- TARGET SYSTEMS DEVELOPMENT
- ADVANCED TECHNOLOGY COCKPIT

Table 6-6. Selected programs at the Naval Air Development Center (NADC).

d) The Naval Coastal Systems Center (NCSC) is located in Panama City, Fl., and has responsibility for navy systems in the shallow waters of coastal regions. This includes mine countermeasures and support for the Marine Corps in amphibious operations. Tables 6-7 and 6-8 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR MINE AND UNDERSEA COUNTERMEASURES, SPECIAL WARFARE, AMPHIBIOUS WARFARE, DIVING, AND OTHER NAVAL MISSIONS THAT TAKE PLACE PRIMARILY IN THE COASTAL REGIONS.

TECHNICAL DEPARTMENTS

- RESEARCH AND TECHNOLOGY
- WARFARE ANALYSIS
- COASTAL WARFARE SYSTEMS
- UNDERSEA WARFARE SYSTEMS
- OCEAN ENGINEERING

PERSONNEL

- TECHNICAL	635
- OTHER	781
	1416

BUDGET

- BASIC RESEARCH	$ 8M
- OTHER RESEARCH	$ 91M
- OTHER APPROP.	$ 64M
	$ 163M

Table 6-7. The Naval Coastal Systems Center (NCSC).

- TACTICS DEVELOPMENT AND EVALUATION
- EXERCISE ANALYSIS AND EVALUATION
- AIRBORNE MINE NEUTRALIZATION SYSTEM
- ADVANCED MINEHUNTING/RECONNAISSANCE
- MINE WARFARE SIMULATOR
- MINEHUNTING SONAR
- ACOUSTIC MINESWEEPING
- SURFACE SHIP MINE COUNTERMEASURES
- CATAPULT LAUNCHED FUEL-AIR EXPLOSIVES
- ADVANCED TORPEDO DECOY
- ADVANCED SEAL DELIVERY SYSTEM
- UNDERWATER BREATHING APPARATUS
- LIGHTWEIGHT DIVING SYSTEM
- SUBMARINE HULL WELD INSPECTION
- RAPID SHALLOW WATER MINE COUNTERMEASURES
- PASSIVE TORPEDO DETECTION SYSTEMS
- ADVANCED TORPEDO DEFENSE
- SPECIAL WARFARE MISSION SUPPORT
- AMPHIBIOUS WARFARE ANALYSIS
- STRATEGIC SEALIFT SYSTEMS INTEGRATION
- LCAC LIFE CYCLE/FLEET SUPPORT
- LOGISTICS OVER-THE-SHORE ANALYSIS
- AMPHIBIOUS ASSAULT VEHICLE MINE PLOW
- LAND MINE COUNTERMEASURES

Table 6-8. Selected Programs at the Naval Coastal Systems Center (NCSC).

0e) The Naval Ocean Systems Center (NOSC) is located on Point Loma in San Diego, Ca. Historically it has been closely associated with ocean underwater systems, especially acoustics. It is the lead lab in command control and communications. Tables 6-9 and 6-10 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR COMMAND CONTROL, COMMUNICATIONS, OCEAN SURVEILLANCE, SURFACE- AND AIR-LAUNCHED UNDERSEA WEAPONS SYSTEMS, AND SUBMARINE ARCTIC WARFARE.

TECHNICAL DEPARTMENTS

- COMMAND AND CONTROL
- MARINE SCIENCES AND TECHNOLOGY
- ANTISUBMARINE WARFARE
- SURVEILLANCE
- COMMUNICATIONS
- ENGINEERING AND COMPUTER SCIENCES

PERSONNEL

- TECHNICAL	1605
- OTHER	1730
	3335

BUDGET

- BASIC RESEARCH	$ 26M
- OTHER RESEARCH	$ 332M
- OTHER APPROP.	$ 172M
	$ 530M

Table 6-9. The Naval Ocean Systems Center NOSC).

COMMAND CONTROL AND COMMUNICATIONS (C3)

- BATTLE FORCE TACTICAL TRAINER
- JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)
- OCEAN SURVEILLANCE INFORMATION SYSTEM (OSIS)
- HUMAN FACTORS TECHNOLOGIES

COMMUNICATIONS

- EHF SATELLITE COMMUNICATIONS
- SUBMARINE LASER COMMUNICATIONS
- SECURE VOICE SHIP CONNECTIVITY

OCEAN SURVEILLANCE

- TOWED, AUTONOMOUS, AND DEPLOYABLE ARRAYS
- SIGNAL PROCESSING FOR SURVEILLANCE SYSTEMS
- ELECTROMAGNETIC SURVEILLANCE SYSTEMS
- DEFENSE AGAINST CRUISE MISSILE THREATS

ANTISUBMARINE WARFARE

- VERTICAL LAUNCH ANTISUBMARINE ROCKET (ASROC)
- SHIP TORPEDO DEFENSE
- TORPEDO REAL TIME SIMULATION
- UNDERWATER FIRE CONTROL SYSTEMS

OCEAN ENGINEERING

- MINE NEUTRALIZATION
- REMOTE UNMANNED UNDERSEA SEARCH

Table 6-10. Selected Programs at the Naval Ocean Systems Center.

f) The Naval Surface Warfare Center (NSWC) is at two locations, at White Oak, Md., just north of the beltway near Washington DC, and at Dahlgren, Va., about two hours from White Oak by car. As its name suggests, it is primarily involved in all aspects of surface-fired weapons from guns to missiles, as well as mines and related systems. Tables 6-11 and 6-12 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR SURFACE SHIP WEAPONS SYSTEMS, ORDNANCE, MINES, AND STRATEGIC SYSTEMS SUPPORT.

TECHNICAL DEPARTMENTS

- ENGINEERING
- ELECTRONIC SYSTEMS
- WEAPONS SYSTEMS
- PROTECTION SYSTEMS
- STRATEGIC SYSTEMS
- COMBAT SYSTEMS
- RESEARCH AND TECHNOLOGY
- UNDERWATER SYSTEMS

PERSONNEL

- TECHNICAL	2546
- OTHER	2698
	5244

BUDGET

- BASIC RESEARCH	$ 7M
- OTHER RESEARCH	$ 363M
- OTHER APPROP.	$ 387M
	$ 757M

Table 6-11. The Naval Surface Weapons Center (NSWC).

COMBAT SYSTEMS

- AEGIS
- TOMAHAWK
- RAPID ASM INTEGRATED DEFENSE SYSTEM

UNDERWATER SYSTEMS

- CAPTOR AND QUICKSTRIKE MINE SYSTEMS
- UNDERWATER WARHEADS

ELECTRONIC SYSTEMS

- ELECTRONIC WARFARE SYSTEMS
- MULTISENSOR INTEGRATION

WEAPONS SYSTEMS

- STANDARD MISSILE
- GUIDED MUNITIONS
- SURFACE LAUNCHED FUSING

PROTECTION

- MAGNETIC SILENCING
- NUCLEAR EFFECTS

TECHNOLOGY

- CHARGED PARTICLE BEAM
- HYPERSONIC WEAPONS
- PULSED POWER

Table 6-12. Selected Programs at the Naval Surface Weapons Center.

g) The Naval Weapons Center (NWC) is both a large laboratory and a series of test ranges in the California desert east of Bakersfield and the Sierras at China Lake. Its remote location makes it ideal for developing and testing air weapons. Tables 6-13 and 6-14 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR AIR WEAPONS SYSTEMS (EXCEPT ANTISUBMARINE WARFARE SYSTEMS) AND MISSILE WEAPONS SYSTEMS, AND THE NATIONAL RANGE/FACILITY FOR PARACHUTE TEST AND EVALUATION.

TECHNICAL DEPARTMENTS

- WEAPONS PLANNING
- AIRCRAFT WEAPONS INTEGRATION
- ORDNANCE SYSTEMS
- SYSTEMS ENGINEERING
- ATTACK WEAPONS
- ENGINEERING
- TECHNOLOGY ADVANCEMENT
- RESEARCH
- INTERCEPT WEAPONS

PERSONNEL

- TECHNICAL	1975
- OTHER	3959
	5934

BUDGET

- BASIC RESEARCH	$ 7M
- OTHER RESEARCH	$ 429M
- OTHER APPROP.	$ 344M
	$ 780M

Table 6-13. The Naval Weapons Center (NWC).

MISSILES AND ORDANANCE

- ADVANCED AIR-TO-AIR MISSILE (AAAM)
- ADVANCED MEDIUM-RANGE AIR-TO-AIR MISSILE (AMRAAM)
- FRE-FALL WEAPON FUSING
- FUEL AIR EXPLOSIVES
- HIGH SPEED ANTIRADIATION MISSILE (HARM)
- HARPOON/SLAM
- PHOENIX
- TOMAHAWK

TACTICAL ELECTRONIC WARFARE AND COUNTERMEASURES

- RADAR WARNING RECEIVERS
- ELECTRONIC WARFARE THREAT SIMULATION
- STRIKE ELECTRONIC WARFARE SIMULATOR

CREW AND AIRCRAFT SURVIVABILITY

- EJECTION AND RECOVERY SYSTEMS
- SEAWATER ACTIVATED RELEASE SYSTEM

OPERATIONS RESEARCH AND SYSTEMS ANALYSIS

- SOVIET SHIP VULNERABILITY
- WEAPONS AND TACTICS

RESEARCH AND TECHNOLOGY ADVANCEMENT

- AIR-LAUNCHED WEAPONRY
- EXPLOSIVES TECHNOLOGIES
- MANUFACTURING TECHNOLOGY
- RING LASER AND FIBER-OPTIC GYRO TECHNOLOGIES

Table 6-14. Selected Programs at the Naval Weapons Center.

h) The Naval Underwater Systems Center (NUSC) is located at Newport, RI., and New London, Conn. As its title suggests, its efforts are almost entirely related to submarines and their weapons. Tables 6-15 and 6-16 give the mission, overall size and structure, and selected program areas.

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR SUBMARINE WARFARE AND SUBMARINE WEAPONS SYSTEMS.

TECHNICAL DEPARTMENTS

- SUBMARINE COMBAT SYSTEMS
- SURFACE ANTISUBMARINE WARFARE
- SUBMARINE ELECTROMAGNETIC SYSTEMS
- TEST AND EVALUATION
- ENGINEERING AND TECHNICAL SUPPORT
- COMBAT SYSTEMS ANALYSIS
- SUBMARINE WARFARE SYSTEMS

PERSONNEL

- TECHNICAL	2071
- OTHER	1581
	3652

BUDGET

- BASIC RESEARCH	$ 5M
- OTHER RESEARCH	$ 311M
- OTHER APPROP.	$ 354M
	$ 670M

Table 6-15. The Naval Underwater Systems Center (NUSC).

SUBMARINE COMBAT SYSTEMS

- ACOUSTIC COMMUNICATIONS
- MINE DETECTION AND AVOIDANCE SONAR
- TOMAHAWK MISSILE INTEGRATION
- SUBMARINE ELECTRONIC WARFARE

SUBMARINE WEAPON AND LAUNCH SYSTEM

- TORPEDO TECHNOLOGY AND DEVELOPMENT
- UNMANNED UNDERSEA VEHICLE
- ADVANCED MOBILE ACOUSTIC TORPEDO TARGET
- TOMAHAWK CRUISE MISSILE

WARFARE ANALYSIS AND PREDICTION

- ASW TESTBED DEVELOPMENT
- SURFACE SHIP ACOUSTIC ANALYSIS
- FLEET EXCERCISE RECONSTRUCTION

TEST AND EVALUATION

- WEAPON RADIATED NOISE MEASUREMENT
- UNDERSEA RANGE TECHNOLOGY AND DEVELOPMENT

Table 6-16. Selected Programs at the Naval Underwater Systems Center.

7. The University Research Centers.

This section contains short decriptions of the four university based not-for-profit resrch centers that report to SPAWARS (see Figure 3-1). More detailed descriptions can be found in reference (11).

a) The Applied Physics Laboratory at Johns Hopkins University (APL/JHU) is located between Washington D.C. and Baltimore at Laurel Md., and has supported navy research since 1942. It has been heavily involved in the strategic systems program, both in SSBN security and in ballistic missile design and development. Tables 7-1 and 7-2 give the mission, overall size and structure, and selected program areas.

MISSION

TO PROVIDE ESSENTIAL RDT&E IN SUPPORT OF CURRENT NAVY STRATEGIC AND TACTICAL FORCES,AND TO CONDUCT RELATED SCIENTIFIC AND TECHNICAL PROGRAMS ON BEHALF OF OTHER MILITARY AND CIVILIAN GOVERNMENT AGENCIES.

TECHNICAL DEPARTMENTS

- AERONAUTICS
- NAVAL WARFARE ANALYSIS
- SUBMARINE TECHNOLOGY
- FLEET SYSTEMS
- STRATEGIC SYSTEMS
- SPACE SYSTEMS

PERSONNEL

- TECHNICAL	1586
- OTHER	1190
	2766

BUDGET

- BASIC RESEARCH	$ 1M
- OTHER RESEARCH	$ 181M
- OTHER APPROP.	$ 255M
	$ 437M

Table 7-1. The Applied Physics Laboratory at Johns Hopkins University (APL/JHU).

SPACE SYSTEMS
- MARS OBSERVER
- SPACE TELESCOPE
- STRATEGIC DEFENSE INITIATIVE

FBM SUBMARINE SECURITY
- SSBN SECURITY TECHNOLOGY
- SSBN TACTICAL DEVELOPMENT
- SSBN COMMUNICATIONS EVALUATION

INTEGRATED COMBAT SYSTEMS
- AEGIS
- HARPOON
- TOMAHAWK
- NATO SEASPARROW

MISSILE SYSTEMS
- STANDARD MISSILE
- AMRAAM

ELECTRONIC WARFARE
- EF111A
- EA-6B
- JOINT EW

BALLISTIC MISSILE SYSTEMS
- TRIDENT 1
- TRIDENT 2

Table 7-2. Selected Programs at the Applied Physics Lab at JHU.

b) The Applied Physics Laboratory at the University of Washington (APL/UW) is located on the west campus of the University of Washington in Seattle, and has been involve with navy research since world war II, primarily in the ocean sciences. Tables 7-3 and 7-4 give the mission, overall size and structure, and selected program areas.

MISSION

TO CONDUCT A UNIVERSITY-BASED PROGRAM OF FUNDAMENTAL RESEARCH, TECHNOLOGICAL ADVANCEMENT, AND ENGINEERING EMPHASIZING NAVY APPLICATIONS OF OCEAN SCIENCE, OCEAN ACOUSTICS, AND OCEAN ENGINEERING, AND TO PLAY A MAJOR ROLE IN TEACHING AND GRADUATE EDUCATION IN MISSION AREAS.

TECHNICAL DEPARTMENTS

- OCEAN PHYSICS
- POLAR SCIENCE
- OCEAN ACOUSTICS
- ARCTIC
- SIGNALS AND SYSTEMS
- ELECTRONIC SYSTEMS
- OCEAN ENGINEERING

PERSONNEL

- TECHNICAL	130
- OTHER	62
	192

BUDGET

- BASIC RESEARCH	$ 9M
- OTHER RESEARCH	$ 9M
- OTHER APPROP.	$ 7M
	$ 25M

Table 7-3. The Applied Physics Laboratory at the University of Washington (APL/UW).

- POLAR SCIENTIFIC RESEARCH
- EXPERIMENTAL PHYSICAL OCEANOGRAPHY
- ACOUSTIC SURVEY SYSTEMS
- OCEAN ENVIRONMENTAL ACOUSTICS
- SPECIAL ACOUSTIC SYSTEMS
- TRANSDUCERS
- UNMANNED UNDERWATER VEHICLES
- ASW TARGETS AND COUNTERMEASURES
- EXPLODERS
- ASW SENSOR PERFORMANCE ASSESSMENT
- MARINE CORROSION

Table 7-4. Selected Programs at the Applied Physics Lab at UW.

c) The Applied Research Laboratory at Penn State University (ARL/PSU) is located in State College, Pa and has been involved with navy research since its founding in 1945. It specializes in all aspects of underwater warfare. Tables 7-5 and 7-6 give the mission, overall size and structure, and selected program areas.

MISSION

TO PROVIDE ESSENTIAL RDT&E IN GUIDANCE, CONTROL, AND PROPULSION OF UNDERSEA WEAPONS, AND PROPULSION TECHNOLOGY, HYDRODYNAMICS AND HYDROACOUSTICS FOR UNDERSEA VEHICLES AND WEAPONS.

TECHNICAL DEPARTMENTS

- POWER AND MECHANICAL SYSTEMS
- FLUID DYNAMICS AND TURBO MACHINERY
- GUIDANCE AND CONTROL
- ENGINEERING MATERIALS
- SYSTEMS ENGINEERING AND ACOUSTICS
- MANUFACTURING SCIENCE

PERSONNEL

- TECHNICAL	339
- OTHER	296
	635

BUDGET

- BASIC RESEARCH	$ 1M
- OTHER RESEARCH	$ 43M
- OTHER APPROP.	$ 8M
	$ 57M

Table 7-5. The Applied Research Laboratory at Penn State University (ARL/PSU).

- TORPEDO GUIDANCE AND CONTROL
- ARCTIC UNDERSEA WEAPONS TECHNOLOGY
- THERMAL PROPULSION TECHNOLOGY
- HYDRODYNAMICS AND HYDROACOUSTICS
- TORPEDO PROPULSORS AND QUIETING
- WEAPON SYSTEM SIMULATION AND MODELLING
- ACOUSTIC AND UNDERWATER COMMUNICATION
- MANUFACTURING SCIENCE
- COMPOSITE MATERIALS
- MK-48 AND MK-50 TORPEDOS
- SURFACE SHIP PROPULSORS
- SUBMARINE PROPULSORS

Table 7-6. Selected Programs at the Applied Research Laboratory at PSU.

d) The Applied Research Laboratory at the University of Texas (ARL/UT) is located in Austin, Texas. It was formed in 1964 by the merger of two labs that were established in world war II to study navy surface-to-air missiles and underwater acoustics. Tables 7-7 and 7-8 give the mission, overall size and structure, and selected program areas.

MISSION

TO CONTRIBUTE TO FUNDAMENTAL SCIENTIFIC AND ENGINEERING ADVANCES IN ACOUSTICS, ELECTROMAGNETICS, AND COMPUTER ENGINEERING, TO INTERPRET AND TRANSITION BASIC AND APPLIED RESEARCH FROM ACADEMIA TO THE DEPARTMENT OF DEFENSE.

TECHNICAL DEPARTMENTS

- ENGINEERING ACOUSTICS
- ADVANCED SONAR
- SIGNAL PHYSICS
- ENVIRONMENTAL SCIENCES
- ELECTRMAGNETICS

PERSONNEL

- TECHNICAL	212
- OTHER	207
	419

BUDGET

- BASIC RESEARCH	$ 2M
- OTHER RESEARCH	$ 21M
- OTHER APPROP.	$ 6M
	$ 29M

Table 7-7. The Applied Research Laboratory at the University of Texas.

- HIGH RESOLUTION SONAR
- ASW PASSIVE SONAR
- ASW ACTIVE SONAR
- SATELLITE GEODESY
- INFORMATION AND DATA MANAGEMENT
- ACOUSTIC MINE MECHANISMS

Table 7-8. Selected Programs at the Applied Physics Laboratory at UT.

8. Other Navy Laboratories.

Besides the NRL and the SPAWARS laboratories described in the previous section, there are a number of laboratories whose interests overlap with those of NPS faculty. Table 8-1 shows the ones with which faculty have interacted in the past.

OTHER LABORATORIES & CENTERS

- NAVAL PERSONNEL RESEARCH & DEVELOPMENT CENTER (NPRDC), SAN DIEGO, CA (IN-HOUSE)
  REPORTS TO THE CHIEF OF NAVAL PERSONNEL (OP-01)

- NAVAL OCEANOGRAPHIC RESEARCH LABORATORY (NORAL), MONTEREY, CA (IN-HOUSE)
  REPORTS TO ONR

- NAVAL AIR ENGINEERING CENTER (NAEC), LAKEHURST, NJ
  REPORTS TO COMNAVAIRSYSCOM (IN-HOUSE)

- NAVAL AIR PROPULSION CENTER (NAPC), TRENTON, NJ
  REPORTS TO COMNAVAIRSYSCOM (IN-HOUSE)

- NAVAL TRAINING SYSTEMS CENTER (NTSC), ORLANDO, FL
  REPORTS TO COMNAVAIRSYSCOM (IN-HOUSE)

- NAVAL EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY CENTER (NEODTC), INDIAN HEAD, MD
  REPORTS TO COMNAVSEASYSCOM (IN-HOUSE)

- MARINE PHYSICAL LABORATORY, SCRIPPS INSTITUTE SAN DIEGO, CA (CONTRACT)

- SYSTEMS RESEARCH CENTER, VIRGINIA POLYTECHNIC INSTITUTE, BLACKSBURG, VA (CONTRACT)

- CENTER FOR NAVAL ANALYSES (CNA), ALEXANDRIA, VA
  REPORTS TO DIRECTOR, NAVY PROGRAM RESOURCE APPRAISAL, OP-81 (CONTRACT)

Table 8-1. Other Navy Laboratories and Centers.

The titles of most of these labs/centers clearly indicate their role. The Lakehurst center has prime responsibility for development of equipment such as ejection seats, catapults,

arrestor gear, and other specialized equipment necessary for naval aviation. Under the Laboratory consolidation plan (see reference (12)), NORAL will become a meteorological branch of NRL located in Monterey. They develop forcasting models for the Fleet Numerical Oceanographic Center (FNOC), an operational unit colocated on Navy property near the Monterey airport and a tenant activity of NPS. NTSC is primarily involved in aviation training, and has responsibility for the numerous fight simulators throughout the Navy. Like Fort Ord it is on the base closure list. NPRDC is well known to NPS faculty in AS and OR. It has responsibility for RDT&E in the navy training system, in addition to all aspects of recruiting, maintaining personnel, career planning, personnel assignment etc. CNA is to the Navy what RAND is to the Airforce. It is heavily involved in studies and analysis for OPNAV in support of Navy programs. CNA personnel work on studies in areas such as the new aircraft carrier, the navy of the next century etc. Their Operations Evaluation Group (OEG) dates back to World War II with some of the pioneers in OR, especially in ASW and convoy tactics. Civilian OEG personnel are located with all Fleet staffs around the world, and are major contributors to fleet tactics and operations.

Further details on each of these activities can be found in reference (7).

9. The Operational Test and Evaluation Force.

Before new platforms (submarines, ships, airplanes), weapons systems, sensors, communications systems etc. are accepted in the fleet they must undergo testing in an operational environment. The reader can see from Table 5-1 that the budget system allows for this with 6.6 funds. The organization responsible for this program is the Operational Test and Evaluation Force (OPTEVFOR) headquarted in Norfolk, VA. Some of the units belonging to OPEVFOR are shown in Table 9-1.

Although OPTEVFOR is much closer to the operational navy than to basic and applied R&D, NPS has significant interactions with this organization. Courses in OT&E are taught and research projects in the area sponsored. These latter tend to be in how to build models or design experiments in an operational environment to adequately evaluate new or modified systems. There are numerous opportunities in this difficult field.

- OPERATES TEST RANGES AND FACILITIES AT WIDELY DISTRIBUTED LOCATIONS, INCLUDING SHIPS AND AIRCRAFT.

  THESE INCLUDE:

  - AIR TEST AND EVALUATION SQUADRONS
    VX1 AT PATUXENT RIVER, MD
    VX4 AT POINT MUGU, CA
    VX5 AT CHINA LAKE, CA

  - PACIFIC MISSILE TEST CENTER
    (PMTC) POINT MUGU, CA

  - NAVAL WEAPONS EVALUATION FACILITY
    (NWEF) ALBUQUERQUE, NM

  - OPTEVFOR DETACHMENT
    SUNNYVALE, CA

  - NAVAL ORDNANCE MISSILE TEST STATION
    WHITE SANDS, NM

  - ATLANTIC FLEET WEAPONS TRAINING FACILITY
    PUERTO RICO

Table 9-1. Selected OPTEVFOR Facilities and locations.

REFERENCES

1. Sea Power (Special Edition), Navy League of the United States, Arlington, Va., January 1991.

2. Guide to the Soviet Navy, Fifth Edition, Naval Institute Press, Annapolis, Md., (1990).

3. The Military Balance 1990-1991, The International Institute for Strategic Studies, London (1991).

4. Science and Technology Planning Guidance, Office of the Chief of Naval Operations (serial 987C/OS560838), 2 May 1990 (SECRET).

5. The DOD Critical Technologies Plan, Office of the Secretary of Defense, report AD-A219 300, 15 March 1990.

6. DON Exploratory Development (6.2) Investment Strategy, Office of Naval Technology, July 1990.

7. RDT&E/Acquisition Management Guide, NAVSO P-2457(Rev. 1-89), Department of the Navy, January 1989.

8. Funding Procedures for Naval Postgraduate School Academic Research, SECNAV Instruction 7040.12A, 8 December, 1989.

9. NRL Review, Naval Research Laboratory, Publication 158-4831, June 1990, Washington D.C. 20375-5000.

10. The NRL 1990 Fact Book, Naval Research Laboratory, Publication 157-4830, July 1990, Washington D.C. 20375-5000.

11. The RDT&E Center Management Briefs, Volume 1, Space and Naval Warfare Systems Command, September 1989, Washington D.C. 20363-5100.

12. DON RDT&E, Engineering and Fleet Support Activities Consolidation Plan, Secretary of the Navy Memorandum of 12 April 1991.

Initial Distribution List

	Copies
Dean of Research (Code 08)	50
Department of Computer Science (Code CS)	10
Department of Mathematics (Code MA)	10
Department of Administrative Sciences (Code AS)	25
Department of Operations Research (Code OR)	20
Department of National Security Affairs (Code NS)	10
Department of Physics (Code PH)	15
Department of Electrical & Computer Engineering (Code EC)	20
Department of Meteorology (Code MR)	5
Department of Aeronautics & Astronautics (Code AA)	10
Department of Oceanography (Code OC)	5
Department of Mechanical Engineering (Code ME)	10
ASW Academic Group (Code AW)	2
Space Systems Academic Group (Code SP)	2
Electronic Warfare Academic Group (Code EW)	2
C3 Academic Group (C3 Academic Group)	2
Provost (Code 01)	1
Dean of Faculty (Code 07)	1
Dean of Instruction (Code 06)	1
Professor Marshall (Code OR/MT)	25
Office of the Chief of Naval Operations (OP-914) Washington D.C. 20350 (Attention: Dr Frank Shoup)	2
Dudley Knox Library (Code 52)	2